BLENDING CHLORAMINATED AND CHLORINATED WATER

Rules Affected: Title 30 Texas Administrative Code (30 TAC) §290.39(j), §290.39(l), and §290.42(e)(3)(G)

Background

This TCEQ staff guidance document is provided to TCEQ staff in order to ensure a consistent review of exception requests for blending chloraminated and chlorinated waters.

Many public water systems (PWSs) use chloramines as a disinfectant in treatment processes and throughout the distribution system. Chloramines maintain a longer-lasting disinfectant residual and also help reduce the levels of regulated disinfection byproducts such as trihalomethanes (THMs) and total haloacetic acids (HAA5s) which are produced by chlorine disinfectants. With chloramines, there is less free chlorine available for interaction with naturally-occurring organic matter, thus reducing the potential to form THMs and HAA5s. However, some PWSs utilize both chloramines and free chlorine as a disinfectant; oftentimes, sources of water containing these two different disinfectants will "blend" in a storage tank or in distribution. These "blending zones" must be monitored to ensure compliant disinfectant residuals are maintained.

History

Until July 30, 2015, all systems using chloramines needed an exception to 30 TAC §290.42(e)(3)(G). With the rule change effective July 30, 2015, **only systems** that blend chloraminated and chlorinated water or use both free chlorine and chloramines as disinfectants in the distribution system in isolated areas are required to have an exception. The monitoring, operation, notification, design, calibration and recordkeeping requirements for systems with a chloramine residual are included in the rules.

Under these rules, the PWS must request an exception to use both free chlorine and chloramines in their system, as 30 TAC §290.42(e)(3)(G) states, **"if water containing chloramines and water containing free chlorine are blended."** All requests for exceptions must be received and approved (or denied) in writing by the TCEQ. Once written notification and an exception request are provided to the TCEQ, staff will review the submittal, grant or deny the exception, as well as notify the PWS if engineering plans and specifications are required to be submitted.

Chloramine Chemistry

Chloramines are formed by combining ammonia and chlorine. The chemistry of this reaction is described by the 'breakpoint' reaction, which is primarily dependent on pH and the ratio of chlorine to ammonia-nitrogen (Cl_2:NH_4-N). Regulations in 30 TAC §290.110(b)(2) set minimum and maximum disinfectant residual levels. Furthermore, the regulations in §290.110(c)(5) specify chloramine effectiveness monitoring for total chlorine, monochloramine, free ammonia, nitrite, and nitrate. Total chlorine measures the sum of all oxidative species present, including free chlorine, monochloramine,

dichloramine, trichloramine, and any oxidative organoamines. The desirable species is monochloramine, which is responsible for disinfection. In a blending scenario, when water with a free chlorine residual "blends" with water utilizing chloramines, the Cl_2:NH_4-N ratio changes in an uncontrolled manner, which can cause disinfectant residuals to drop and create aesthetically unpleasing water.

Nitrification Action Plans (NAPs)

Systems that distribute chloraminated water must develop a nitrification action plan (NAP), as required in 30 TAC §290.46(z), to prevent or respond to potential issues of nitrification. Since PWSs that blend chloraminated and chlorinated water run the risk of encountering zones where the Cl_2:NH_4-N ratio changes in an uncontrolled manner—which can cause disinfectant residuals to drop and create aesthetically unpleasing water— the creation of a NAP (or implementation of an existing one) should be reiterated in exception letters to ensure the PWS meets the NAP requirement.

Guidance

Grant or Deny Exception

The exception request will be granted, temporarily granted (to allow the PWS to collect additional data), or denied based on a review of the submittal's merits and after review by the TCEQ's Technical Review and Oversight Team and the applicable TCEQ region. Appropriate correspondence will be drafted and sent to system officials. The correspondence will either:

a. Grant the exception request and formalize conditions the PWS must meet to sustain the granted exception.

b. Temporarily grant the exception request and formalize conditions the PWS must meet in order to allow review of adequate data for the consideration of a final exception.

c. State why the exception cannot be granted, and request additional information for further review if needed.

Blending Scenarios

1. Blending chloraminated and chlorinated water in distribution:

Mixing chlorinated and chloraminated water is not recommended. When the stream of water with free chlorine meets the stream of water with chloramines, the Cl_2:NH_4-N ratio changes in an uncontrolled manner, which can cause disinfectant residuals to drop and create aesthetically unpleasing water.

If a PWS is blending chlorinated and chloraminated water, they must perform sampling to ensure that the Cl_2:NH_4-N ratio is maintained in a way that ensures the formation of monochloramine, which is the only chloramine species that provides reliable disinfection. Note that if an exception is granted (temporarily or without an expiration date), additional monitoring will also be required to ensure a compliant disinfectant residual is maintained at all locations in the distribution system. Language regarding the potential issues related to blending chlorinated and chloraminated water should be included in the exception letter. A PWS that is

blending chlorinated and chloraminated water may consider the following alternatives in lieu of obtaining an exception:

a. *Ammoniate the Chlorinated Water:* The PWS may use chloramines in the entire distribution system by adding ammonia after free chlorine injection to the water that is treated with free chlorine. If the PWS wishes to pursue this option, engineering plans and specifications must be submitted to the TCEQ's Plan Review Team (PRT) (MC 159) for review and to receive approval prior to construction as specified in 30 TAC §290.39(j)(1)(A).

   An exception will be required until the PWS chloraminates all water sources. The PWS will need to develop a NAP for all portions of their system which receive chloraminated water.

b. *Chloraminating Groundwater with Naturally Occurring Ammonia:* The natural occurrence of ammonia in groundwater sources may combine with the free chlorine used to disinfect PWS wells to create chloramines. In order to determine if there is naturally occurring ammonia in a PWS's groundwater source(s), the PWS must collect raw water samples from their well(s) to be analyzed for free ammonia (reported as mg/L NH_3 as Nitrogen). The samples must be submitted for analysis at a TCEQ-accredited laboratory with a current National Environmental Laboratory Accreditation Program (NELAP) certification. Under this scenario, plans and specifications may be required to be submitted to the TCEQ PRT if the PWS would like to install liquid ammonia sulfate (LAS) facilities as a contingency.

   No exception will be needed if the PWS chloraminates all water sources. The PWS must develop a NAP for all portions of their system which receive chloraminated water.

c. *Breakpoint Chlorinate:* The PWS may use free chlorine in the entire distribution system. To do so, the PWS must ensure that all of the water enters specific storage tanks prior to distribution - specifically, that chloraminated water is delivered to a designated tank with chlorination facilities before distribution. Sufficient free chlorine must then be added to the designated storage tank(s) to transform ("breakpoint") the chloramines, and the PWS must monitor for free chlorine in the distribution system. Please note that due to the additional chlorine required for this option, the PWS may encounter elevated concentrations of disinfection byproducts. If the PWS wishes to pursue this option, they must provide the following information prepared by a licensed professional engineer to the TCEQ's PRT for review and to receive approval:

   i. Drawings showing the piping modifications to be performed to deliver the purchased chloraminated water to the storage tanks.

   ii. Drawings of all current purchased water interconnections that currently feed to storage tanks.

   iii. Locations of all chlorine injection and monitoring points at the storage tanks where chloraminated water is introduced.

   iv. Documentation of the method for determining the proper amount of chlorine to be added. The PWS should show the range of purchased water flow rates and chloramine residual expected.

   No exception will be needed if the PWS chlorinates all of their water sources. However, our letter must specify that the PWS must meet the

monitoring requirements in §290.110(c)(5)(C) at all locations where breakpoint chlorination is occurring. Note: This may constitute a change in treatment for the system. Discuss with senior staff whether the PWS should undergo reduced lead and copper monitoring as a result of breakpoint chlorinating.

d. *Isolate Disinfectants:* The PWS may physically isolate areas of the distribution with free chlorine from areas with chloramines. Free chlorine should be monitored in the portions of the distribution system that are supplied solely by chlorinated water. Chloramine effectiveness monitoring, as required in §290.110(c)(5), should be performed in the portions of the distribution system that are supplied by chloraminated water. If the PWS wishes to pursue this option, they must provide the following information:

   i. A distribution map of the PWS, showing how the areas of different disinfectants will be divided. The PWS should indicate which portion(s) will be disinfected with free chlorine and which portion(s) disinfected with chloramines.

   ii. The map must include all entry points, storage tanks, treatment facilities, service area boundaries, pressure-maintenance facilities (tanks and pumps), and points at which wholesale water is delivered to any downstream PWSs.

   iii. The map must show distribution piping starting from largest to smallest, to the extent that a clear view of the general layout is given. For example, a medium-sized PWS might show water mains from their maximum of 12-inch outer diameter down to a diameter of 4 inches.

   iv. If the PWS is proposing the use of valves to isolate the two areas utilizing chloramines and chlorine, each valve must be identified by location, such as geographical coordinates.

   An exception must be requested for this option. The exception will document that even though there are two different disinfectants utilized in the distribution system, those disinfectants are not blending together. Plans and specifications must be submitted for any new equipment used to physically isolate areas of the distribution system. A NAP must be developed for the portion of the PWS that utilizes chloraminated water.

e. *Ensure Controlled Blending:* For this option, a PWS must develop a method that will ensure free and total chlorine residuals will remain acceptable in a blended distribution system by injecting the appropriate amount of chlorine in the free-chlorinated well water to combine with free ammonia present in the chloraminated water. If the PWS wishes to pursue this option, they must provide the following information:

   i. Documentation showing how blending occurs.

   ii. A map that identifies the area(s) of blending ("blending zones").

   iii. Information explaining how the areas of blending will be monitored and documented during actual operations. As demands change, the blending zone(s) can also change. For example, how will a PWS determine where the blending area is if one of their potable water sources is inactive for a period of time?

iv. Documentation of the sampling type and frequency that the PWS will perform to ensure adequate chlorine/chloramine residuals.

v. Documentation of the sample type and frequency that the PWS will perform to ensure monochloramine--not di- nor tri-chloramine—is being formed.

vi. Documentation of the sample type and frequency that the PWS will perform to ensure nitrification is not present in the blending area.

vii. Documentation of the corrective actions to be taken if the sampling shows inadequate disinfectant residuals, taste and odor issues, bacteriological sample issues, or potential nitrification.

All of the information listed above (Items i-vii) should be included in the PWS's NAP.

An exception must be requested for this option. If the exception is granted, the exception letter will provide the monitoring and other activities that must occur. The PWS will need to develop a NAP for the portion of their system that utilizes chloramines.

2. Blending chloraminated and chlorinated water in a tank:

Mixing chlorinated and chloraminated water is not recommended. When the stream of water with free chlorine meets the stream of water with chloramines, the ratio of chlorine, ammonia, and monochloramine changes in an uncontrolled manner.

If a PWS blends chlorinated and chloraminated water in a storage tank, the PWS must perform sampling to ensure that the Cl_2:NH4-N ratio is maintained in a way that ensures the presence of monochloramine, which is the only chloramine species that provides reliable disinfection. If a system blends chloraminated water and chlorinated water in a storage tank, the PWS must first ensure that no unplanned blending occurs. A PWS may consider the following alternatives in lieu of obtaining an exception:

a. *Ammoniate the Chlorinated Water:* The PWS may add ammonia after free chlorine injection to the water that uses free chlorine, thus creating the chloramines in a controlled manner. If the PWS wishes to pursue this option, engineering plans and specifications must be submitted to the TCEQ's PRT for review and to receive approval prior to construction as specified in 30 TAC §290.39(j)(1)(A). **No exception will be needed if the PWS chloraminates all water sources**. However, sampling in the effluent of the blending tank is required. The PWS will need to develop a NAP for all portions of their system which receive chloraminated water.

b. *Breakpoint Chlorinate:* The PWS may use free chlorine. To do so, they must ensure that all of the water enters storage tanks prior to distribution, and that chloraminated water is delivered to a designated tank with chlorination facilities located prior to distribution. Sufficient free chlorine must then be added to the designated storage tank(s) to transform ("breakpoint") the chloramines, and the PWS must monitor for free chlorine in the distribution system. Please note that due to the additional chlorine required for this option, the PWS may encounter elevated concentrations of disinfection byproducts. If the PWS wishes to pursue this option, they must provide the following information

prepared by a licensed professional engineer to the TCEQ's PRT for review and to receive approval:

i. Drawings showing the piping modifications needed to deliver all of the chloraminated water to the storage tank(s).

ii. Drawings of all current water interconnections that feed the storage tank(s).

iii. Locations of all chlorine injection and monitoring points at the storage tank(s) where chloraminated water will be introduced.

iv. Documentation of the method for determining the proper amount of chlorine to be added to the tank(s). The PWS should show the range of purchased water flow rates and chloramine residual expected.

No exception will be needed if the PWS chlorinates all water sources. However, sampling at the tank effluent must occur to ensure that free chlorine is produced. Our letter must specify that the PWS must meet the monitoring requirements in §290.110(c)(5)(C) at all locations where breakpoint chlorination is occurring. Systems that purchase chloraminated water and breakpoint chlorinate before their entry point(s) do not need to meet the NAP requirements in §290.46(z).

c. *Ensure Controlled Chloramine Formation after Mixing the Sources in the Tank:* For this option, a PWS must develop a method that will ensure that chlorine and chloramine residuals will remain acceptable in water leaving the tank by injecting the appropriate amount of chlorine and ammonia at all times. If the PWS wishes to pursue this option, they must provide the following information:

i. Documentation showing that the tank is completely mixed.

ii. Documentation of the free chlorine, total chlorine, free ammonia, and monochloramine sampling locations and frequency that the PWS will perform to know the appropriate amount of chlorine and ammonia dose.

iii. Documentation of the calculations used to determine the dose of chlorine and ammonia to apply.

iv. Documentation of the sample type and frequency that the PWS will perform to ensure monochloramine--not di- nor tri-chloramine—is being formed.

v. Documentation of the corrective actions to be taken if the sampling shows inadequate disinfectant residuals, taste and odor issues, bacteriological sample issues, or potential nitrification. This should be a part of the NAP required by §290.46(z) and attached to the Monitoring Plan (see #7 in the "Additional Items" section below).

An exception must be requested for this option. If the exception is granted, the exception letter will provide the monitoring and other activities that must occur. The PWS will need to develop a NAP for the portion of their system that utilizes chloramines.

3. Blending Disinfectants under Emergency Scenarios:

If a PWS maintains an emergency source or interconnect that contains a different disinfectant than what the PWS distributes under normal operations, the PWS must

ensure that if the emergency source is utilized, blending occurs in a controlled manner. An exception will be required to address specific monitoring and notification activities when an emergency source is utilized.

a. Blending chloraminated and chlorinated water during an emergency. If the PWS utilizes both their emergency source and their non-emergency source(s) during an emergency, and waters with different disinfectants are blended and distributed, an exception will be required to ensure that blending occurs in a controlled manner. Depending on the blending scenario occurring during the emergency (blending in distribution, blending in a tank, etc.), the exception will provide monitoring and notification requirements that the PWS must meet for the duration of the emergency. Once the emergency source is turned on, the PWS must contact the TCEQ Drinking Water Quality Team to schedule entry point sampling at their emergency source entry point. If the emergency source contains a chloramine residual, the PWS will be required to meet all the chloramine monitoring requirements in 30 TAC §290.110(c) once the source has been used for seven (7) calendar days.

b. Utilizing only the emergency source during an emergency. If the PWS will only use their emergency source (and shut off the source or sources used under normal operating conditions), an exception will provide monitoring, flushing, and notification requirements to minimize blending zones that occur during the transition between disinfectants. Once the emergency source is turned on, the PWS must contact the TCEQ Drinking Water Quality Team to schedule entry point sampling at their emergency source entry point. If the emergency source contains a chloramine residual, the PWS will be required to meet all the chloramine monitoring requirements in 30 TAC §290.110(c) once the source has been used for seven (7) calendar days.

An exception must be requested for this option. If the exception is granted, the exception letter will provide the monitoring and other activities that must occur during the emergency where blending is occurring.

4. "Seasonal" Blending Scenarios:

Some PWSs will utilize one disinfectant—either free chlorine or chloramines—for the majority of a calendar year. However, when water demands exceed the capacity of the PWS's active potable drinking water sources, a seasonal source may be utilized to meet the system's water demands. However, if the use of the seasonal source results in two disinfectants being used at the PWS, then the system is blending during their peak demand scenario, and an exception request must be submitted for review.

An exception must be requested for this scenario. The PWS will be required to submit documentation specific to their blending scenario (blending in distribution, in a tank, etc.), and provide detailed information regarding the PWS's procedures documenting when the seasonal source is utilized, the frequency in which the seasonal source is utilized, etc.

Additional Items

1. **Plan Review:** Rule 30 TAC §290.39(l)(1) states that requests for exceptions are to precede the submission of engineering plans and specifications. If the PRT receives a submittal for an exception request, the submittal will be forwarded to

TROT so that the exception request(s) can be logged into the Water Utilities Database (WUD) for evaluation by TROT.

a. If engineering plans and specification were not received by TROT with the written notification, TROT must determine whether they are required. Engineering plans and specifications are not required if all of the chemical feed facilities have already been approved.

b. If TROT determines that engineering plans and specifications are required after the blending chloramines exception is granted, the TCEQ's correspondence will contain the following conditions to be met by the PWS:

   i. Engineering plans and specifications must be submitted to the PRT for review; and

   ii. The PWS must receive written approval to construct from the PRT before construction can be started.

c. If TROT determines that engineering plans and specifications are not required, the TCEQ's correspondence will state that the PWS is not required to submit engineering plans and specifications.

2. **Public Notification and TCEQ Notification:** Per the requirements in 30 TAC §290.110(g)(6), a PWS that uses chloramines must notify their retail and wholesale customers of the use of chloramines. The public notification language in 30 TAC §290.47(h) will be required for customers having the potential to receive chloraminated water in a blended system.

3. **Design of Chloramination Systems:** The design requirements in 30 TAC §290.42(e) apply to any portion of the system that is creating chloramines, or boosting chloramines.

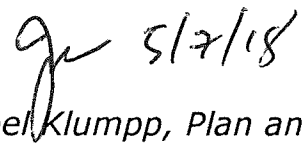
4. **Monitoring Frequency and Locations:** The sampling requirements in 30 TAC §290.110(c)(5) are required for any portion of the system that contains chloramines. If the system is changing chloraminated water to chlorinated water, the only chloramination-effectiveness monitoring required is in the plant(s) that is (are) performing breakpoint chlorination. All sampling must be documented in the system's monitoring plan per 30 TAC §290.121, and all sampling locations for chloramine effectiveness monitoring must be documented in the PWS's NAP per §290.110(c)(5).

5. **Analytical Methods:** The sampling requirements and calibration requirements in 30 TAC §290.110(d) and §290.46(s), respectively, are required for any portion of the system that is creating chloramines, boosting chloramines or changing chloramines to free chlorine.

6. **Recordkeeping:** The record retention requirements in 30 TAC §290.46(f) are required for any portion of the system that is creating chloramines, boosting chloramines or converting chloramines to free chlorine.

7. **Nitrification Action Plans:** The requirement for a NAP in 30 TAC §290.46(z) applies to any portion of the system that is creating chloramines or boosting chloramines. If the system is breakpoint chlorinating, a NAP is required only for the plant(s) that is (are) performing the breakpoint chlorination.

Finalized and Approved by:



Joel Klumpp, Plan and Technical Review Section Manager, 05/07/2018

If no formal expiration date has been established for this staff guidance, it will remain in effect until superseded or canceled.

Revision History:

Date	**Action**	**Action by**
09/23/2015	Approved	Joel Klumpp
10/16/2017	Revised	Yadhira Resendez
05/07/2018	Approved	Joel Klumpp